ECONOMIC GEOLOGY

AND THE

BULLETIN OF THE SOCIETY OF ECONOMIC GEOLOGISTS

EDITOR: MARCO T. EINAUDI

Economic Geology, P.O. Box 20524, Stanford, CA 94309 (650) 725-8701, FAX: (605) 725-8704
E-mail: econgeol@pangea.stanford.edu

BUSINESS/PRODUCTION OFFICE

Economic Geology, 7811 Shaffer Parkway, Littleton, CO 80127 TEL: (720) 981-7882, FAX: (720) 981-7874
Email: seg@segweb.org

EDITORIAL BOARD

Through 2000

J. BRUCE GEMMELL, *Hobart, Australia*
CHRISTOPH A. HEINRICH, *Zürich, Switzerland*
MURRAY W. HITZMAN, *Golden, Colorado*
FRANÇOIS ROBERT, *Verdun, Canada*
ROBERT A. ZIERENBERG, *Davis, California*

Through 2001

ROBERT A. AYUSO, *Reston, Virginia*
ANNE-MARIE BOULLIER, *Grenoble, France*
KEVIN F. CASSIDY, *Perth, Australia*
DAVID A. JOHN, *Menlo Park, California*
JEREMY P. RICHARDS, *Edmonton, Canada*

Through 2002

SARAH-JANE BARNES, *Chicoutimi, Canada*
JOHN DILLES, *Corvallis, Oregon*
MARK HANNINGTON, *Ottawa, Canada*
JOHN MOORE, *Grahamstown, South Africa*
KRISTER SUNDBLAD, *Trondheim, Norway*

Through 2003

RODNEY ALLEN, *Boliden, Sweden*
CHARLES ALPERS, *Sacramento, California*
MARIA BONI, *Naples, Italy*
MARK D. BARTON, *Tucson, Arizona*
BRUCE W. MOUNTAIN, *Taupo, New Zealand*

Through 2004

DAVID R. BURROWS, *Mississauga, Canada*
JEAN S. CLINE, *Las Vegas, Nevada*
JEFFREY W. HEDENQUIST, *Ottawa, Canada*
YUKIHIRO MATSUHISA, *Tsukuba, Japan*
JOHN MAVROGENES, *Canberra, Australia*

ASSISTANT TO THE EDITOR: ANN HILL

Production Staff

DIRECTOR OF PUBLICATION PRODUCTION: LISA LAIRD
DIRECTOR OF EDITING: ALICE BOULEY

VOLUME 95
LITTLETON, COLORADO
THE ECONOMIC GEOLOGY PUBLISHING COMPANY

2000

SOCIETY OF ECONOMIC GEOLOGISTS

SELECTED PUBLICATIONS OF WHICH CONSTITUTE A PART OF THIS JOURNAL

OFFICERS

April 1, 2000 - March 31, 2001

James M. Franklin, *President*
24 Commanche Drive
Nepean, Ontario K1A 0E8
Canada

Frederick M. Beck, *Vice President*
1 Main Street
Yarmouth, Me 04096-6716

David I. Groves, *President-Elect*

Murray W. Hitzman, *Vice President-Elect*

Richard H. Sillitoe, *Past President*

Holly J. Stein, *Past Vice President*

Brian G. Hoal, *Executive Director*
7811 Shaffer Parkway
Littleton, Colorado 80127

Thomas A. Loucks, *Treasurer*
7811 Shaffer Parkway
Littleton, Colorado 80127

Jeffrey W. Hedenquist, *Vice President-Regional Affairs*

Regional Vice Presidents
W.E.L. Minter, Africa
Graciano P. Yumul, Jr., Asia
Peter J. Legge, Oceania
Antonio Arribas M., Europe
Tawn Albinson, North America
César E. Vidal, South America

SEG Foundation
Roger A. Newell, *President*

Economic Geology Publishing Company
Brian J. Skinner, President
Marco T. Einaudi, Editor

Soc. Géol. Appliquée aux Gites Minéraux
Heikki T. Papunen, President
Jan Pasava, Executive Secretary

Councilors

(To serve until March 31 of year listed)

2001	2002	2003
Lluis Fontboté	Virginia S. Gillerman	Mark D. Hannington
François Robert	Robert W. Schafer	Christoph A. Heinrich
C. Eric Seedorff	John F. H. Thompson	Noel C. White

EDITOR, *SEG Field Trip Guidebook Series* - Tommy B. Thompson

COMMITTEES

(To serve until March 31 of year listed)

Executive Committee
James M. Franklin, *Chair*
Frederick M. Beck
David I. Groves
Jeffrey W. Hedenquist
Brian G. Hoal
Thomas A. Loucks
Richard H. Sillitoe
Roger A. Newell, *ex officio*
Brian J. Skinner, *ex officio*

Editorial Advisory Board
Raymond M. Coveney, Jr., 2001, *Chair*
Alex C. Brown, 2001
Marco T. Einaudi, 2001
John F. Slack, 2001
Peter G. Vikre, 2001
Brian G. Hoal, *ex officio*

Admissions Committee
Donald J. Birak, 2001, *Chair*
Howard G. Coopersmith, 2001
William X. Chávez, Jr., 2002
J. Bruce Gemmell, 2002
Richard J. Herrington, 2002
Dale R. Finn, 2003

Committee On Committees
A. James Macdonald, 2001, *Chair*
John-Mark G. Staude, 2001
Robert C. Bell, 2001
Laurence J. Robb, 2001
Robert J. Casacelli, 2001
Craig A. Feebrey, 2001

Distinguished Lecturer Committee
Anne J.B. Thompson, 2002, *Chair*
Aoki Masahiro, 2001
Christoph A. Heinrich, 2001
Alex C. Brown, 2002
Hugo T. Dummett, 2002
Timothy Baker, 2003

Finance Committee
Gary C. Huber, 2003, *Chair*
John C. Wilson, 2001
George P. Ireland, 2002
Frederick T. Graybeal, 2003
John A. Thoms, 2003
Thomas A. Loucks, *ex officio*

International Exchange Lectureship Committee
Patrick J. Williams, 2002, *Chair*
Christine Horrigan, *Secretary, ex officio*
Antonio Arribas R., 2001
J.P.N. Badham, 2002
Maria Boni, 2002
Ross R. Large, 2002
Paul G. Spry, 2003

Lindgren Award Committee
Scott A. Wood, 2002, *Chair*
Gregory A. Hahn, 2001
Anthony Williams-Jones, 2001
Judith L. Hannah, 2002
David R. Cooke, 2003
Richard Jemielita, 2003

Membership Committee
Fred W. Warnaars, 2002, *Chair*
David A. Giles, 2001
John L. Walshe, 2001
Jose A. Perello, 2002
Robert R. Seal II, 2003
Toru Shimizu, 2003

Nominating Committee
C. Eric Seedorff, 2001, *Chair*
Francisco Camus, 2001
Virginia S. Gillerman, 2001
Christopher J. Hodgson, 2001
Stuart F. Simmons, 2001
Robert P. Foster, 2001

Program Chair Panel (not a committee)
Greg B. Arehart, GSA '00, 2001
Diane Wolfgram, SME '01, 2001
John F. Slack, GSA '01, 2002
To Be Named, SME '02, 2002
Albert Hofstra, GSA '02, 2003
To Be Named, SME '03, 2003

Program Committee
Holly J. Stein, 2001, *Chair*
All Program Chairs
Frederick M. Beck, 2002
Murray W. Hitzman, 2003
Krister Sundblad, 2001
To Be Named, 2002
To Be Named, 2003
Richard M. Tosdal, 2001, *ex officio*
Richard I. Grauch, 2002, *ex officio*
Brian G. Hoal, *ex officio*

Research Committee
Richard I. Grauch, 2002, *Chair*
Martin B. Goldhaber, 2001
David L. Huston, 2001
Erich U. Petersen, 2001
Jeremy P. Richards, 2002
Enrique Tidy, 2002
Noel C. White, 2002
Cornel E.J. DeRonde, 2003
Jamie J. Wilkinson, 2003
Holly J. Stein, *ex officio*
Jeffrey W. Hedenquist, *ex officio*
Brian G. Hoal, *ex officio*

Society Short Course Committee
Richard M. Tosdal, 2001, *Chair*
John L. Jambor, 2002
James Rytuba, 2002
Ross R. Large, 2003
Brent I.A. McInnes, 2003
Julia A. Rosdeutscher, 2003

Student Affairs Committee
Stuart F. Simmons, 2002, *Chair*
Krister Sundblad, 2001
To Be Named, 2001
Marcos Zentilli, 2002
John L. Muntean, 2003
Ross Sherlock, 2003

Thayer Lindsley Visiting Lecturer Committee
Leslie A. Landefeld, 2001, *Chair*
Clay T. Smith, *Secretary, ex officio*
Cameron R. Allen, 2001
Lluis Fontboté, 2002
Jeffrey W. Hedenquist, 2002
Odin Christensen, 2003
Roger J. Kuhns, 2003

ECONOMIC GEOLOGY PUBLISHING COMPANY OFFICERS

Brian J. Skinner, *President* — Samuel S. Adams, *Vice President* — Charles G. Cunningham, *Secretary* — Thomas A. Loucks, *Treasurer*

Marco T. Einaudi, *Editor*

SOCIETY OF ECONOMIC GEOLOGISTS FOUNDATION OFFICERS

Roger A. Newell, *President* — Richard L. Nielsen, *Vice President* — Donald G. Bryant, *Secretary* — Thomas A. Loucks, *Treasurer*

CONTENTS OF VOLUME 95

Number 1

The Importance of Oxidized Brines for the Formation of Australian Proterozoic Stratiform Sediment-Hosted Pb-Zn (Sedex) Deposits — *David R. Cooke, Stuart W. Bull, Ross R. Large, and Peter J. McGoldrick* 1

Metallogenesis of Zn-Pb Carbonate-Hosted Mineralization in the Southeastern Region of the Picos de Europa (Central Northern Spain) Province: Geologic, Fluid Inclusion, and Stable Isotope Studies — *F. Gómez-Fernández, R. A. Both, J. Mangas, and A. Arribas* 19

A Brittle Failure Mode Plot Defining Conditions for High-Flux Flow — *Richard H. Sibson* 41

The Archean Amphibolite Facies Coolgardie Goldfield, Yilgarn Craton, Western Australia: Nature, Controls, and Gold Field-Scale Patterns of Hydrothermal Wall-Rock Alteration — *Joseph T. Knight, John R. Ridley, and David I. Groves* 49

Lithological and Structural Controls on the Form and Setting of Vein Stockwork Orebodies at the Mount Charlotte Gold Deposit, Kalgoorlie — *John Ridley and Faron Mengler* 85

Origin of Massive Calcite Veins in the Golden Cross Low-Sulfidation Epithermal Au-Ag Deposit, New Zealand — *Stuart F. Simmons, Greg Arehart, Mark P. Simpson, and Jeffrey L. Mauk* 99

Layering and Precious Metals Mineralization in the Rincón del Tigre Complex, Eastern Bolivia — *M. D. Prendergast* 113

Three-Dimensional Oxygen Isotope Imaging of Convective Fluid Flow around the Big Bonanza, Comstock Lode Mining District, Nevada — *Robert E. Criss, M. J. Singleton, and D. E. Champion* 131

The Hydrothermal Geochemistry of Tungsten in Granitoid Environments: I. Relative Solubilities of Ferberite and Scheelite as Function of T, P, pH, and m_{NaCl} — *Scott A. Wood and Iain M. Samson* 143

Hydrothermal Alteration and Fluid Chemistry of the Endako Porphyry Molybdenum Deposit, British Columbia — *David Selby, Bruce E. Nesbitt, Karlis Muehlenbachs, and Walter Prochaska* 183

Supergene Ferromanganese Wad Deposits Derived from Permian Karoo Strata along the Late Cretaceous–Mid-Tertiary African Land Surface, Ryedale, South Africa — *A. Pack, J. Gutzmer, N. J. Beukes, H. S. van Niekerk, and S. Hoernes* 203

Scientific Communications

Fluid Inclusion Study of Stibnite Using Infrared Microscopy: An Example from the Brouzils Antimony Deposit (Vendée, Armorican Massif, France) — *Laurent Bailly, Vincent Bouchot, Claire Bény, and Jean-Pierre Milési* 221

The Origin of Greisen Fluids of the Foley's Zone, Cleveland Tin Deposit, Tasmania, Australia — *Peter Jackson, Amarendra Changkakoti, R. Roy Krouse, and John Gray* 227

Discussions

The Manganese Formation of the Neoproterozoic Penganga Group, India—Revision of an Enigma—A Discussion — *Supriya Roy* 237

The Manganese Formation of the Neoproterozoic Penganga Group, India—Revision of an Enigma—A Reply — *J. Gutzmer and N. J. Beukes* 239

Clay Mineralogy, Crystallinity, and K-Ar Ages of Illites within the Polish Zechstein Basin: Implications for the Age of Kupferschiefer Mineralization—A Discussion *Jerzy Nawrocki* 241

Clay Mineralogy, Crystallinity, and K-Ar Ages of Illites within the Polish Zechstein Basin: Implications for the Age of Kupferschiefer Mineralization—A Reply *A. Bechtel, W. C. Elliott, J. M. Wampler, and S. Oszczepalski* 243

Reviews

Digital International Metallogenic Map of Africa, Sheets 5 and 6: CD-ROM (Milica Veselinovic-Williams and E. C. I. Hammerbeck, compilers) *L. B. Chorlton* 245

Books Received 247

Interesting Papers in Other Journals 249

Instructions to Authors, 2000 255

Number 2

Gold in Porphyry Copper Deposits: Experimental Determination of the Distribution of Gold in the Cu-Fe-S System at 400° to 700°C *Grigore Simon, Stephen E. Kesler, Eric J. Essene, and Stephen L. Chryssoulis* 259

Foraminiferal Coloration Index as a Guide to Hydrothermal Gradients around the Porgera Intrusive Complex, Papua New Guinea *Mark Gunson, Greg Hall, and Mike Johnston* 271

Wall-Rock Petrology and Geochemistry in Alteration Halos Associated with Mesothermal Gold Mineralization, Central Victoria, Australia *F. P. Bierlein, D. C. Arne, S. McKnight, J. Lu, S. Reeves, J. Besanko, J. Marek, and D. Cooke* 283

Bulk Rock and Melt Inclusion Geochemistry of Bolivian Tin Porphyry Systems *Andreas Dietrich, Bernd Lehmann, and Alex Wallianos* 313

The Genesis of Hydrothermal Fluorite-REE Deposits in the Gallinas Mountains, New Mexico *Anthony E. Williams-Jones, Iain M. Samson, and Gema R. Olivio* 327

Geology and Ore Petrography of Permian Kuroko-Type Volcanogenic Massive Sulfide Deposits of the Bully Hill Area, East Shasta District, California *Michael M. Gustin and Christopher J. Eastoe* 343

Formation and Transformation of Clay Minerals in the Hydrothermal Deposits of Middle Valley, Juan de Fuca Ridge, ODP Leg 169 *K. S. Lackschewitz, A. Singer, R. Botz, D. Garbe-Schönberg, P. Stoffers, and K. Horz* 361

Gold-Bearing Breccias of the Rain Mine, Carlin Trend, Nevada *Cindy L. Williams, Tommy B. Thompson, Jon L. Powell, and W. Warren Dunbar* 391

Geochemistry and Petrology of Some Proterozoic Banded Iron-Formations of the Quadrilátero Ferrífero, Minas Gerais, Brazil *C. Klein and E. A. Ladeira* 405

Genesis of Vein Stockwork and Sedimentary Magnesite and Hydromagnesite Deposits in the Ultramafic Terranes of Southwestern Turkey: A Stable Isotope Study *Veysel Zedef, Michael J. Russell, Anthony E. Fallick, and Allan J. Hall* 429

Reviews

Dérive des Continents, Peléoclimats et Altérations Tropicales (Yves Tardy and Claude Roquin) *Fabrice Colin* 447

Books Received 448

Interesting Papers in Other Journals 449

Number 3

Underground Fumaroles: "Excess Heat" Effects in Vein Formation	*R. W. Henley and G. O. Hughes*	453
A Fluid Inclusion Study of Au-Bearing Quartz Vein Systems in the Central and North Deborah Deposits of the Bendigo Gold Field, Central Victoria, Australia	*Y. Jia, X. Li, and R. Kerrich*	467
The Nature and Genesis of Gold-Silver-Tellurium Mineralization in the Metaliferi Mountains of Western Romania	*David H. M. Alderton and Anthony E. Fallick*	495
Mineralogical and Chemical Studies of Volcanic-Related Argillaceous Industrial Minerals of the Central American Cordillera (Western El Salvador)	*H. G. Dill, H.-R. Bosse, and J. Kassbohm*	517
The Origin of Platinum Group Minerals from the Freetown Intrusion, Sierra Leone, Inferred from Osmium Isotope Systematics	*J. F. W. Bowles, I. C. Lyon, J. M. Saxton, and D. J. Vaughan*	539
Origin of Platinum-Bearing Placers in the Aluchin Horst, Russian Far East	*Stanislav S. Gornostayev, Alexander D. Dodatko, Kauko V.O. Laajoki, and Alexander G. Mochalov*	549
Hydrothermal Mobilization of High Field Strength Elements in Alkaline Igneous Systems: Evidence from the Tamazeght Complex (Morocco)	*Stefano Salvi, François Fontan, Pierre Monchoux, A. E. Williams-Jones, and Bernard Moine*	559
Diffusion and Reaction-Controlled Cu-Pb-Zn Ore Mineral Precipitation in a Reducing System: A Model Applied to the Pattern of Ore Mineral Precipitation in the Kupferschiefer and Other Black Shales	*D. J. Large and J. S. Small*	577
Vein and Karst Barite Deposits in the Western Jebilet of Morocco: Fluid Inclusion and Isotope (S, O, Sr) Evidence for Regional Fluid Mixing Related to the Central Atlantic Rifting	*Katia Valenza, Robert Moritz, Abdellah Mouttaqi, Denis Fontignie, and Zachary Sharp*	587
Sedimentary Origin of the Mn-Fe Ore of Um Bogma, Southwest Sinai: Geochemical and Paleomagnetic Evidence	*N. L. ElAgami, E. H. Ibrahim, and H. H. Odah*	607
Oxygen and Carbon Isotope Study of Natural and Synthetic Azurite	*Erik B. Melchiorre, Robert E. Criss, and Timothy P. Rose*	621
Significant Deposits of Gold, Silver, Copper, Lead, and Zinc in the United States	*Keith R. Long, John H. DeYoung, Jr., and Steve Ludington*	629
Scientific Communications		
The Pallacos of Cerro Rico de Potosi, Bolivia: A New Deposit Type	*Paul J. Bartos*	645
4,500-Year-Old Mining Pollution in Southwestern Spain: Long-Term Implications for Modern Mining Pollution	*M. Leblanc, J. A. Morales, J. Borrego, and F. Elbaz-Poulichet*	655
Reviews		
Regional Geochemistry of North-East England. Regional Geochemistry of Parts of North-West England and North Wales. British Geological Survey	*Jörg Matschullat*	663
Books Received		664
Interesting Papers in Other Journals		665
Erratum		669
SOCIETY OF ECONOMIC GEOLOGISTS		
Thayer Lindsley Lecturers for 2000–2001		671

Number 4

A SPECIAL ISSUE ON VOISEY'S BAY NI-CU-CO DEPOSIT
ANTHONY J. NALDRETT AND CHUSI LI, EDITORS

Preface	*Colin B. McKenzie*	673
Introduction	*A. J. Naldrett*	675
The Evolution of Troctolitic and High Al Basaltic Magmas in Proterozoic Anorthosite Plutonic Suites and Implications for the Voisey's Bay Massive Ni-Cu Sulfide Deposit	*James S. Scoates and Jeremy N. Mitchell*	677
The Nain-Churchill Boundary and the Nain Plutonic Suite: A Regional Perspective on the Geologic Setting of the Voisey's Bay Ni-Cu-Co Deposit	*Bruce Ryan*	703
Threading the Eye of the Needle: Lessons from the Search for Another Voisey's Bay in Labrador, Canada	*Andrew Kerr and Bruce Ryan*	725
Physical Controls Associated with the Distribution of Sulfides in the Voisey's Bay Ni-Su-Co Deposit, Labrador	*D. M. Evans-Lamswood, D. P. Butt, R. S. Jackson, D. V. Lee, M. G. Muggridge, R. I. Wheeler, and D. H. C. Wilton*	749
Contrasting Petrological and Geochemical Relationships in the Voisey's Bay and Mushuau Intrusions, Labrador, Canada: Implications for Ore Genesis	*Chusi Li, Peter C. Lightfoot, Yuri Amelin, and A. J. Naldrett*	771
Melting Reactions of Gneissic Inclusions with Enclosing Magma at Voisey's Bay, Labrador, Canada: Implications with Respect to Ore Genesis	*Chusi Li and A. J. Naldrett*	801
Nd-Pb-Sr Isotope Systematics of Crustal Assimilation in the Voisey's Bay and MushUau Intrusions, Labrador, Canada	*Yuri Amelin, Chusi Li, Oleg Valayev, and A. J. Naldrett*	815
Oxygen Isotope Studies of the Voisey's Bay Ni-Cu-Co Deposit, Labrador, Canada	*Edward M. Ripley, Young-Rok Park, Chusi Li, and A. J. Naldrett*	831
The Composition of Mineralization at the Voisey's Bay Ni-Cu Sulfide Deposit, with Special Reference to Platinum-Group Elements	*A. J. Naldrett, Mohammed Asif, Sasha Krstic, and Chusi Li*	845
Re-Os Isotope Systematics of the Voisey's Bay Ni-Cu-Co Magmatic Sulfide System, Labrador, Canada: II. Implications for Parental Magma Chemistry, Ore Genesis, and Metal Redistribution	*David D. Lambert, Louise R. Frick, Jeffrey G. Foster, Chusi Li, and A. J. Naldrett*	867
The Mineralogy of Voisey's Bay Ni-Cu-Co Deposit, Northern Labrador, Canada: Influence of Oxidation State on Textures and Mineral Compositions	*A. J. Naldrett, Jagmohan Singh, Sasha Krstic, and Chusi Li*	889
Constraints on Oxygen Fugacity during Sulfide Segregation in the Voisey's Bay Intrusion, Labrador, Canada	*James M. Brenan and Chusi Li*	901
Interesting Papers in Other Journals		917

SOCIETY OF ECONOMIC GEOLOGISTS

1999 Awards and Medals: Penrose Gold Medal, SEG Silver Medal, Marsden Award	921

Number 5

Origin of Cu-Ni-PGE Sulfide Mineralization in the Partridge River Intrusion, Duluth Complex, Minnesota	*Robert D. Thériault, Sarah-Jane Barnes, and Mark J. Severson*	929
A Gold- and Platinum-Mineralized Layer in Gabbros of the Kap Edvard Holm Complex: Field, Petrologic, and Geochemical Relations	*John G. Arnason and Dennis K. Bird*	945
Hydrothermal Minerals and Precious Metals in the Broadlands-Ohaaki Geothermal System: Implications for Understanding Low-Sulfidation Epithermal Environments	*Stuart F. Simmons and Patrick R. L. Browne*	971
Mineralization and Hydrothermal History of the Tiwi Geothermal System, Philippines	*Joseph N. Moore, Thomas S. Powell, Matthew T. Heizler, and David I. Norman*	1001
Round Hill Shear Zone-Hosted Gold Deposit, Macraes Flat, Otago, New Zealand: Evidence of a Magmatic Ore Fluid	*Cornel E. J. de Ronde, Kevin Faure, Colin J. Bray, and David J. Whitford*	1025
The Silidor Deposit, Rouyn-Noranda District, Abitibi Belt: Geology, Structural Evolution, and Paleostress Modeling of an Au Vein-Type Deposit in an Archean Trondhjemite	*Alain Carrier, Michel Jébrak, Jacques Angelier, and Peter Holyland*	1049
The Lightning Creek Sill Complex, Cloncurry District, Northwest Queensland: A Source of Fluids for Fe Oxide Cu-Au Mineralization and Sodic-Calcic Alteration	*C. S. Perring, P. J. Pollard, G. Dong, A. J. Nunn, and K. L. Blake*	1067
Iron-Rich and Iron-Poor Mississippi-Valley-Type Mineralization, Metaline District, Washington	*James St. Marie and Stephen E. Kesler*	1091
Mineral Sands Occurrences in the Murray Basin, Southeastern Australia	*Peter S. Roy, John Whitehouse, Peter J. Cowell, and Geoff Oakes*	1107
Sulfate Reduction by Organic Matter in Colombian Emerald Deposits: Chemical and Stable Isotope (C, O, H) Evidence	*Gaston Giuliani, Christian France-Lanord, Alain Cheilletz, Pierre Coget, Yannick Branquet, and Bernard Laumomnier*	1129
Scientific Communications		
Temporal Evolution of Arc Magmatism and Hydrothermal Activity, Including Epithermal Gold Veins, at Borovitsa Caldera, Southern Bulgaria	*Brad Singer and Peter Marchev*	1155
Re-Os and U-Pb Dating of the Vein-Hosted Mineralization at the Kansanshi Copper Deposit, Northern Zambia	*Heidie I. Torrealday, Murray W. Hitzman, Holly J. Stein, Richard J. Markley, Richard Armstrong, and David Broughton*	1165
Reviews		
Development of Regional Exploration Criteria for Buried Carbonate-Hosted Mineral Deposits: A Multidisciplinary Study in Northern England (J.A. Plant and D.G. Jones)	*George Sevastopulo*	1171
Books Received		1172
Interesting Papers in Other Journals		1173
Erratum		1177
SOCIETY OF ECONOMIC GEOLOGISTS		
Marsden Award, 1999		1179

Number 6

A SPECIAL ISSUE DEVOTED TO SKARN DEPOSITS
LAWRENCE D. MEINERT, DAVID R. LENTZ, AND RAINER J. NEWBERRY, EDITORS

Introduction	*Lawrence D. Meinert, David R. Lentz, and Rainer J. Newberry*	1183
Mineralogy, Geochemistry, and Age Constraints on the Zn-Pb Skarn Deposit of Maria Cristina, Quebrada Galena, Northern Chile	*François Lieben, Robert Moritz, and Lluis Fontboté*	1185
Skarns Related to Porphyry-Style Mineralization at Caicayén Hill, Neuquén, Argentina: Composition and Evolution of Hydrothermal Fluids	*Marta B. Franchini, Lawrence D. Meinert, and Teresita F. Montenegro*	1197
Formation of Magnetite-Scheelite Skarn Mineralization at Kara, Northwestern Tasmania: Evidence from Mineral Chemistry and Stable Isotopes	*Khin Zaw and Blackwell Singoyi*	1215
U-Pb Ages Constraining Batholith Emplacement, Contact Metamorphism, and the Formation of Gold and W-Mo Skarns in the Southern Cross Area, Yilgarn Craton, Western Australia	*Andreas G. Mueller and Neal J. McNaughton*	1231
Mineralogy and Metasomatic Evolution of Distal Strata-Bound Scheelite Skarns in the Riba de Alva Mine, Northeastern Portugal	*L. Miguel Gaspar and Carlos M. C. Inverno*	1259
The Geology and Isotope Geochemistry of the Talc Deposits of Puebla de Lillo (Cantabrian Zone, Northern Spain)	*Fernando Tornos and Baruch F. Spiro*	1277
Base Metal Skarns and Au Occurrences in the Southern Gaspé Appalachians: Distal Products of a Faulted and Displaced Magmatic-Hydrothermal System along the Grand Pabos-Restigouche Fault System	*Michel Malo, Robert Moritz, Benoît Dube, André Chagnon, François Roy, and Chantal Pelchat*	1297
A Low F Pegmatite-Related Mo Skarn from the Southwestern Grenville Province, Ontario, Canada: Phase Equilibria and Petrogenetic Implications	*D. R. Lentz and K. Suzuki*	1319
Estimation of Fluorine Concentration in Fluids of Mineralized Skarn Systems	*Anatoly M. Aksyuk*	1339
The Geochemistry of Three Tin-Bearning Skarns and Their Related Plutonic Rocks, Atlin, Northern British Columbia	*G. E. Ray, I. C. L. Webster, S. B. Ballantyne, C. E. Kilby, and S. B. Cornelius*	1349
Interesting Papers in Other Journals		1367

Number 7

Preliminary Fluid Inclusion Constraints on Fluid Evolution in the Bayan Obo Fe-REE-Nb Deposit, Inner Mongolia, China	*Martin P. Smith and P. Henderson*	1371
Regional Fluid Flow and Gold Mineralization in the Dalradian of the Sperrin Mountains, Northern Ireland	*J. Parnell, G. Earls, J. J. Wilkinson, D. H. W. Hutton, A. J. Boyce, A. E. Fallick, R. M. Ellam, S. A. Gleeson, N. R. Moles, P. F. Carey, and I. Legg*	1389
Dike-Hosted Ores of the Beast Deposit and the Importance of Eocene Magmatism in Gold Mineralization of the Carlin Trend, Nevada	*Michael W. Ressel, Donald C. Noble, Christopher D. Henry, and Wayne S. Trudel*	1417

Porphyry Gold Deposits of the Refugio District, Maricunga Belt, Northern Chile — *John L. Muntean and Marco T. Einaudi* 1445

The Middle Valley Sulfide Deposits, Northern Juan de Fuca Ridge: Radiogenic Isotope Systematics — *T. Bjerkgård, B. L. Cousens, and J. M. Franklin* 1473

Age of the Sherman-Type Zn-Pb-Ag Deposits, Mosquito Range, Colorado — *D. T. A. Symons, M. T. Lewchuk, C. D. Taylor, and M. J. Harris* 1489

Fluid Chemistry and Depositional Mechanism of the Epigenetic, Discordant Ores of the Proterozoic, Carbonate-Hosted, Zawarmala Pb-Zn Deposit, Udaipur District, India — *Jawahar Kumar Talluri, H. S. Pandalai, and G. N. Jadhav* 1505

Scientific Communications

Contrasting Fluid Types at the Nevoria Gold Deposit in the Southern Cross Greenstone Belt, Western Australia: Implications of Auriferous Fluids Depositing Ores within an Archean Banded Iron-Formation — *Hong-Rui Fan, David I. Groves, Edward J. Mickucki, and Neal J. McNaughton* 1527

Re-Os Ages for the Erdenet and Tsagaan Suvarga Porphyry Cu-Mo Deposits, Mongolia, and Tectonic Implications — *Yasushi Watanabe and Holly J. Stein* 1537

The Relationship between Intrusion-Hosted Cu-Mo Mineralization and the VMS Deposits of the Archean Sturgeon Lake Mining Camp, Northwestern Ontario — *Alan Galley, Otto van Breemen, and James Franklin* 1543

Experimental Sulfur Isotope Studies of the Pyrite to Pyrrhotite Conversion in a Hydrogen Atmosphere — *Edward M. Ripley and Kossouth Snyder* 1551

Books Received 1555

Interesting Papers in Other Journals 1557

Number 8

Causes for Large-Scale Metal Zonation around Mineralized Plutons: Fluid Inclusion LA-ICP-MS Evidence from the Mole Granite, Australia — *Andreas Audétat, Detlef Günther, and Christoph A. Heinrich* 1563

Regional Crustal Structures and Their Relationship to the Distribution of Ore Deposits in the Western United States Based on Magnetic and Gravity Data — *T. G. Hildenbrand, Byron Berger, R. C. Jachens, & Steve Ludington* 1583

Reactive Models of Ore Formation in the Southeast Missouri District — *Martin S. Appold and Grant Garven* 1605

Gilt by Association? Origins of Pyritic Gold Ores in the Victory Mesothermal Gold Deposit, Western Australia — *J. M. Palin and Y. Xu* 1627

The Werner Lake Co-Cu-Au Deposit of the English River Subprovince, Ontario, Canada: Evidence for an Exhalative Origin and Effects of Granulite Facies Metamorphism — *Yuanming Pan and Craig Therens* 1635

Re-Os Dating of Low-Level Highly Radiogenic (LLHR) Sulfides: The Harnäs Gold Deposit, Southwest Sweden, Records Continental Scale Tectonic Events — *Holly J. Stein, John W. Morgan, and Anders Scherstén* 1657

Systematic Variation in Galena Solid-Solution Compositions at Santa Eulalia, Chihuahua, Mexico — *Virgil W. Lueth, Peter K. M. Megaw, Nicholas E. Pingitore, and Philip C. Goodell* 1673

Isotope Geochemistry of Ankerite-Bearing Veins Associated with the Coeur d'Alene Mining District, Idaho *Philip E. Rosenberg and Peter B. Larson* 1689

Spinels and Mg Ilmenites from the Noril'sk 1 and Talnakh Intrusions and Other Mafic Rocks of the Siberian Flood Basalt Province *Stephen J. Barnes and V. Y. Kunilov* 1701

The Fluid Inclusion and Mineralogic Record of the Transition from Liquid- to Vapor-Dominated Conditions in The Geysers Geothermal System, California *Joseph N. Moore, Michael C. Adams, and Alan J. Anderson* 1719

Overlapping Cretaceous and Eocene Alteration, Twin Creeks Carlin-Type Deposit, Nevada *C. M. Hall, Stephen E. Kesler, Grigore Simon, and John Fortuna* 1739

The Application of Microchemical Analysis of Alluvial Gold Grains to the Understanding of Complex Local and Regional Gold Mineralization: A Case Study in the Irish and Scottish Caledonides *R. J. Chapman, R. C. Leake, N. R. Moles, G. Earls, C. Cooper, K. Harrington, and R. Berzins* 1753

Petrography and Geochemistry of the Eugui Magnesite Deposit (Western Pyrenees, Spain): Evidence for the Development of a Peculiar Zebra Banding by Dolomite Replacement *Stefano Lugli, José Torres-Ruiz, Giorgio Garuti, and Fernando Olmedo* 1775

Interesting Papers in Other Journals 1793

Index, Volume 95 1797

Reviewers of Books 1826

Contents, Volume 95 iii